Oral History of Norman “Norm” Abramson

Interviewed by:
Marc Weber

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Marc Weber: I'm Marc Weber of the Computer History Museum and I'm here on February 25, 2013, with Norm Abramson, the father of wireless networking, and thank you for doing this.

Norman “Norm” Abramson: Happy to be here.

Weber: What is your full name and when and where were you born?

Abramson: Well, my full name is Norman Manuel Abramson. I seem to have dropped the middle name over the years and shortened the first name so it's Norm Abramson. I was born in Boston on April 1, 1932.

Weber: Please tell me about your family, where you grew up.

Abramson: Well, my mother and father were both immigrants, came over to the U.S. in early '20s I guess, and my father was from basically a small town in eastern Europe, Lithuania, my mother was from a large town on the Black Sea, Odessa, and they met here, married here and had two children here.

Weber: You have a brother or a sister?

Abramson: I have a younger sister.

Weber: What did your parents do?

Abramson: My younger sister had more of a—oh, my—we'll start with my father. He was a photographer and—

<interruption>

Abramson: He was a photographer. He then opened what was called in those days a photo finishing laboratory with a partner and then he—that was in Boston. Then he left Boston about the time I was getting my master's degree at UCLA, moved to UCLA with my mother and sister and became a photographer again so he has a—he had a long history of photography.

Weber: Photo finishing then.

Abramson: Photo finishing in those days—I don't know what it is now—essentially means that you took the raw film from other photographers and produced negatives and prints of various sorts so it was sort of large-scale photography production, large-scale picture production.

Weber: Your mother and sister.

Abramson: My mother was more of a conventional housewife, which was the norm in those days, and my sister has had jobs basically as administrative assistants to various medical people, doctors for various kinds of specialties.

Weber: Were you interested in photography or technical things as a child?

Abramson: Never professionally, Marc, but very often personally, and my wife and I have—we both come—she comes from a photography background as well and so we both have a lot of personal photographs and put in various strange formats these days.

Weber: Did you grow up in Boston itself or—

Abramson: I grew up in Boston in a place called Dorchester and I was there until I was 20—until I graduated from Harvard and I was in Cambridge for four years at Harvard.

Weber: What did you like to do as a kid?

Abramson: Well, the usual kids' things although what struck me as I think about it is the thing I liked the most was my father had a ritual where he would close his business on Friday afternoon, take me to one of the beaches in Boston, a place called L Street in south Boston. During the summer we would do that religiously every Friday. And then as I grew older the family would rent a place on the south shore a little bit south of Boston for the summer, and again I remember the most delightful times of my existence as a child was swimming in the frigid waters of the environs of Boston.

Weber: Tell me about your school experience.

Abramson: Well, if you go way back I'm—when I look back on it I'm amazed at the quality of public education back in those days. And remember now this was the late 1930s and 1940s but I went to a local elementary school. I went from there to Boston Latin School, which I believe is the oldest – there's probably an adjective that goes there – but the oldest high school in the U.S. aFrom there I flunked out and, after four years of Latin essentially I was fed up with Latin and I went to Boston English, which was

another of the elite public schools in the Boston area, much more to my liking because I did not have to learn Latin.

Weber: Why did you start at the Latin School?

Abramson: Because it was the only high-quality—I shouldn't say that—not high-quality, but it was sort of an elite school where you had to be in the top two or three people in the class to get in and it seemed to me that it was more fun to be with the smart kids.

Weber: That was more prestigious than the English School.

Abramson: Slightly, but it was the only one I knew of at that age. I was 11 when that decision was made and somehow it was made for me. I made my own decision at 15 when I switched from Latin to English and that was solely on the basis of the fact that I detested learning a dead language.

Weber: What were your favorite subjects?

Abramson: Math, as you might expect. I suppose most of your interviewees—

Weber: No.

Abramson: Okay. Well, mine was math definitely and both in high school and then when I was an undergraduate I was a major for a while and then I graduated as a physics major.

Weber: But science as well or—

Abramson: I was certainly headed toward science; I knew that at an early age but I didn't know enough about what science was or what working in science was to make a reasonable decision until much later.

Weber: Were you interested in building things or the technical end of things?

Abramson: I was more interested in disassembling things and somehow very often I couldn't get them back together again. I remember disassembling a real old typewriter that my father had in his office and never got it together again, but it was still a—at that age it was still a bit of an education to disassemble it.

Weber: Were you interested in music?

Abramson: Only as—again as a listener, not as a generator of music.

Weber: Don't answer this if you don't want to, but may I ask you what values you were raised with?

Abramson: Well—

Weber: Did politics, religion or ethics play an important part in your family?

Abramson: Well, the politics is easy. I was born in 1932, the same year that Franklin Roosevelt became President, and Franklin Roosevelt was the—certainly the political hero of the whole area in Boston where I grew up. The culture in that area was also sort of interesting and it has some analogies in technology. Part of the culture—it was a very Jewish neighborhood but a lot of the people who had come over especially in the '20s most of them were people who were trying to get away from something that was not very good. And they were also trying to fit into something that looked awfully good to them and that was where my father fit, but I also recall way, way back when I was a pretty small kid there were some small ultra-religious groups, one—at least one and probably more, that were trying to—it appeared to me and I thought as a child—trying to re-create part of sort of eighteenth-century eastern Europe and it wasn't working. And it was sort of shrinking pretty rapidly at the time but I remarked on that because it has some analogies in technology.

Weber: You celebrated high holidays or—

Abramson: Yes. My father did some of that. He wasn't particularly observant and I certainly never turned out that way but it didn't bother him one bit.

Weber: In the neighborhood it was Jewish and what other groups or was it—

Abramson: They—we were on the border of an interesting Irish neighborhood and the two groups were—as children the two groups were very often apart but there were always leakages there, and I recall a few leakages which were sort of fun and meeting with kids who had completely different backgrounds than I did.

Weber: Were there any particularly important teachers, people who guided you in high school or—

Abramson: Well, there weren't at Boston Latin School although probably that was my fault 'cause my attitude was colored by having to take a Latin class every day for four years, <laughs> and when I got to English High School there were two teachers that I can remember. One was a bit of a martinet. I remember his name was Charlie Murphy and he was reputed never to give an A in any course that he taught, that was his reputation among the kids, and I resolved to get an A and I did. And then there was a much more sympathetic teacher whose name—last name I remember but I don't remember his first name because I probably always called him Mr. Atwood, and he was a physics teacher and provided my first introduction to physics and I really enjoyed that.

Weber: What was the course that the martinet taught that you got the A in or what—

Abramson: It was standard mathematics for juniors and seniors. I think I had two years with him and I recall going through in amazing detail, and I enjoyed it, a lot of stuff from Euclid, and apparently he liked that enough and, more to the point, I didn't make any errors <laughs> and so I did get an A.

Weber: What did you think you wanted to be when you grew up?

Abramson: Well, like a lot of kids I think I went through stages. I was interested—as a child in high school at least my standard answer was "I'm going to be an aeronautical engineer" 'cause that was one of the technologies that I saw coming up. It was a technology which was clearly just starting and I like to get in fields which are just starting and it was something I wanted to learn. Then when I got to Harvard I think I was in physics for a while, then math for a while, and then back to physics, and the math that made me change was taught by a very competent but very theoretical mathematician and that I knew wasn't my cup of tea. I was more interested in applications so I went to physics.

Weber: Tell me about Harvard and what it was like.

Abramson: Well, the things I remember most about Harvard it turned out—in spite of the fact that I went through math and physics the single class that I recall most at Harvard is one I took in my freshman year by Arthur Schlesinger Jr., which was a cultural history of the United States, and I was just really thrown by that because I had read a little bit about history but the idea of looking at a cultural history was new to me. I loved the idea, I loved the reading, and Schlesinger was a great teacher. He would lecture—his lectures were just—he had the enthusiasm, he loved his subject and he conveyed that to the students, and I remember that course more than most others. I also remember a course by B.F. Skinner, the psychologist who—the Skinner box guy, and I liked that because it sort of gave a—it showed his attempt to make his field more scientific and quantitative. I don't think he was often successful in that but again he was a good lecturer and he conveyed the fact that he really was into his subject. Just thinking about it, I also have memories of one other class, which strangely was a chemistry class and the first and last chemistry class I ever took, but I remember it because the class was taught—again I liked the way the guy taught it. He

was a young new assistant professor I think and passing through Harvard but he loved his subject and he conveyed an enthusiasm in class that I've always thought was a great way to learn stuff. And so I took chemistry seriously when he taught it, I enjoyed his lectures, and at the end of the class—I think I got a good grade—I decided that chemistry was not my cup of tea.

Weber: You later described communication theory as being your field but this is the era—Claude Shannon was around there but that's MIT but this early you had no inkling—

Abramson: Well, I met Claude somewhat later; I was an assistant professor at Stanford at that point and he gave a lecture on what he was doing at IBM, which I remember to this day because it was a great lecture. I don't recall some of the things technically that he talked about, but he was a very good lecturer and I was very interested in that subject by that time. Just talking about great lecturers, probably the greatest—I like this idea of looking at lecturers because I've always tried to be a good lecturer as well as a researcher–but the greatest I ever heard was when I was getting my master's—just jumping around—at UCLA and working at Hughes, where they invited Richard Feynman in to give a talk. And Feynman talked of all things about something new which had just come up in those days—this was '53, '54—namely semiconductors, and there was a big controversy about whether it was going to be silicon or germanium, and Feynman showed clearly that it was going to be silicon and the way he did it with an enormous amount of enthusiasm in his lecture was something that sort of stuck with me for all those years.

Weber: At Harvard you ended up with physics you said.

Abramson: I ended up graduating in physics.

Weber: And thinking that you would do what with that?

Abramson: Wasn't sure. I got a fellowship at UCLA which was part of the Hughes program of fellowships in those days where essentially you'd work half time at Hughes—Hughes Aircraft in L.A.—go to school half time, get a master's degree in two years, and I said, "Okay. Let's try that." And I learned a lot from both Hughes and from UCLA. I learned to perhaps define my interests a little better at Hughes, but at UCLA I don't recall an awful lot but I did take more or less a conventional physics background.

<interruption>

Weber: You were talking about Hughes, the fellowship.

Abramson: Yeah. I got a fellowship at Hughes and I arrived there in July of '53, I graduated June of '53 from Harvard, and July and August of '53 were a very—those two months were extremely active at Hughes because the company was run by two guys named Simon Ramo and Dean Wooldridge and they apparently couldn't work very well with Howard and so they left to form a new company, the Ramo-Wooldridge Corporation, which I think became TRW, Thompson Ramo Wooldridge. And they took with them an awful lot of the key smart people in the company and they went down the line and so I came in and I was looking up the line. My boss was hired by them, my boss's boss was hired by them, my boss's boss who reported to Ramo and Wooldridge was hired by them so as far as I could tell I reported directly to Howard Hughes. I never met Howard Hughes but it was a very tumultuous time at Hughes Aircraft Company, but I did my work and I enjoyed the work and I learned a lot about smart guys to work with and a lot about the real world and how all this math and physics stuff made a difference and could tell you how things worked.

Weber: What were the actual projects you were working on?

Abramson: Well, the project that I contributed to mostly was something called a Falcon, which was an air-to-air missile at that time, and I guess it wasn't classified but it was basically the control system of that particular missile, and something new which was being introduced, which was a digital computer into a missile, and—

Weber: They were analog before that.

Abramson: I guess so. It's the first one I ever worked on so I don't really know, but what I was charged with was looking at what digital computers could do and what missiles could do and rethinking how the computer was used, which I say I did. I think it worked out very well and I designed some control features which made use of the digital computer.

Weber: To step back, as a physics undergrad what led you in a sense back to aeronautical engineering but why were they hiring you to work on that kind of—

Abramson: Well, when I was at Harvard the last semester I was there as an undergraduate I took a course given by Howard Aiken and it was probably the first computer course in the country. I don't know what people at Pennsylvania were doing, maybe they had one too, but Howard Aiken gave a computer course. I heard about it as a physics major and I branched out and I took that course and had a pretty nice time and I did a little trivial paper of something or other on computing—on analyzing theoretically something very basic, I mean we don't think of anymore, was how to represent numbers, whether you want to represent them by actually decimal devices, devices which had three possible states, devices which had two possible states, and I analyzed that from a—sort of a undergraduate—it was a very simple theoretical viewpoint but I guess Howard Aiken thought it was worthwhile. And when I told him that I was

going to—thinking of going to Hughes he said, "Well, let me write you a letter of recommendation" so by then I got the fellowship—I mean before he had wrote anything but he said, "Okay. Here, I'll give you this letter" and he gave me a letter which he sealed to somebody he knew at Hughes Aircraft and I was coming in as a half-time first-job undergraduate or master's candidate. And I looked up this guy and he seemed to me way up in the hierarchy and when I got to Hughes I called his office and said, "I've got a letter from Howard Aiken who asked me to give this to Mr." whoever. Mr. whatever it was. And his office made a quick appointment for me and I came up to his office, which seemed like the most luxurious office I had ever seen until that point, and gave him the letter from Howard Aiken and he read it and he said, "Well, what can I do for you?" and I was still basically an undergrad; I had no idea and I said, "Gee, I don't know. I like what I'm doing now." And so he said, "Fine. I hope you keep doing it" and I shook hands and that was it. I have no idea what if anything he ever did or if he ever did anything. Yeah.

Weber: You did the paper—

Abramson: I did the paper for Howard Aiken.

Weber: You mean the paper for his—

Abramson: For his class and somehow it struck Aiken and he took a liking to me or saw something that I didn't know I had and—

Weber: What was the recommendation?

Abramson: I have no idea. <laughs> I never saw the letter.

Weber: No. Sorry. How did you recommend representing numbers?

Abramson: Oh. I didn't. I wishy-washed. What I did is I optimized some function that I defined which looked like you should optimize it, found that it optimized at ***e***—2.718—and said, "Well, you could do either three or two but probably two is better 'cause it's easier to implement." <laughs>

Weber: That was your first exposure I assume to computing, taking that course.

Abramson: Yeah, taking that course was my first exposure to computing.

Weber: Did you actually see computers or interact with them in any way?

Abramson: Well, that was a pretty interesting part of my first year at Hughes because—remember now I got there in July of '53. The big question to a lot of people in those days was "What kind of computers should we use?" They had been using analog computers and then some new people came up, I guess out of schools, and said, "Gee, we ought to think about digital computers," and there became a wonderful argument—I wasn't involved in it 'cause I didn't know enough for either side—but the digital and the analog people were then going at each other, the analog people saying, "Well, you'll never be able to get a digital computer to go fast enough to give you any results on this" and the digital people making the usual arguments, but I looked at it and what it remind me—reminded me of was my early childhood back in Dorchester with these ultra-religious groups trying to hang on to a reality that wasn't there and the—that was what the analog people were doing. It was very clear to me that digital computers were going to be the winner of that but I was of course not asked and I wasn't about to volunteer my uneducated opinion in this in that time.

Weber: Tell me if I've missed any other key parts at Harvard 'cause clearly that was an important step.

Abramson: Well, Harvard opened up my mind and I am very glad I went to Harvard, unlike Bob Metcalfe. I also had the choice of either Harvard or MIT. I applied to Harvard, MIT and Cal Tech and I was admitted to all three 'cause even though I had flunked out of Latin School—Boston Latin—I did extremely well when I was able to shake the burden of learning Latin at English High School and so I did get in to all those three places. Harvard was sort of an add-on for me when I was applying because I was clearly headed to science and so Cal Tech and MIT were the two places that I had applied, and I had a friend who one day after school said he was going over to Harvard to get an interview and he asked me to come along. And I went along, looked at what was available, talked to a few people there and said, "Okay, I'll have an interview too" and I was interviewed at Harvard and I was admitted. I think Bob did well to go to MIT, but in my case I did well to go to Harvard because it really opened up my mind outside of the area of technology and that stayed with me forever, and it didn't lead to anything professionally but it led to an awful lot in terms of living and what I do.

Weber: You talked about Schlesinger's course and Skinner. Any other outside of science and tech things that made a big impression?

Abramson: Well, I can think of one course that didn't work out too well and that was—again you were forced to expand and take a very broad set of courses at Harvard under what was called the general education program in those days, and I was forced to take—to choose a course in philosophy. I chose sort of a basic course of philosophy and starting with the Greeks and going up to modern European philosophers—I think it was all Western oriented—but the thing that I remember most about that course is I couldn't figure out what it was all about and I kept trying and trying and I didn't do very well. I did well enough, I was probably getting B's, maybe C's, and by the time we got to Kant I was pretty disgusted with the whole thing and I was beginning to have my suspicions. So as we went into Kant—I remember this very well—we had these weekly quizzes and I had been getting B's and C's in those, and I read Kant and

I could not decipher what on earth this guy was trying to say if anything so I memorized a paragraph straight out of Kant and I resolved that when the quiz would be given I would give this paragraph. I don't know. Maybe—I suppose that's plagiarism because I didn't quote it as Kant, I just answered the question by repeating this paragraph, and I got an A in my—the only A I got in my work in that course, and I came to the conclusion that it was not a field I wanted to get into. So I remember that and probably I missed a lot but I drew an undergraduate conclusion at least that philosophy was not worth my spending time on. I suppose I moderated that view since then.

Weber: You lived in Cambridge.

Abramson: For the first semester I did not. Then I looked around and I learned that living on campus was a different experience so I did that, yes.

Weber: How was that?

Abramson: That was great. It's—the whole social experience there is something that opened my eye to a lot of things and developed friendships with people and learned about all sorts of goals and how different people are and I enjoyed it.

Weber: In terms of the Hughes thing, why would a pure physics major be hired by an aircraft company to work on those systems even before Aiken?

Abramson: Well, I have my suspicion about that. The first year when I went to Hughes, maybe for the second year too, I was asked to share an office with a guy named Don Williams who was from Harvard and I think that's why they asked me to share an office with Don. I never got close to Don socially but he was one of these typically brilliant people who could solve any problem that you brought to him, and I did a lot of that with Don and I saw a lot of other people in the company do that too, but Don if you look him up he committed suicide about—I think it was like ten years after I stopped sharing an office with him but he was the co-inventor with Harold Rosen of the geostationary satellite. He was a brilliant guy as is Harold. I think Harold's—hope he's still with us. The geostationary satellite is just the kind of problem that he would do with lots of great mechanics in it and a lot of ingenuity and things that required judgment to come up with a successful product, and they came up with the first geostationary satellite. So I was put in that office and probably the reason I was chosen was that Don was such a successful person at Hughes they said, "Oh, hey, Harvard worked out. Let's get another Harvard guy."

Weber: It's Arthur C. Clarke who claimed to have come up with the idea for the geostationary—

Abramson: Arthur C. Clarke I've talked to him over the years too because of various connections I've had but Clarke wrote the paper that suggested the theoretical underpinnings of the geostationary satellite, but the actual U.S. patent for the first geostationary satellite was in the name of Don Williams and Harold Rosen. And it was an area that I was also working in, which is how I then met Arthur Clarke—I talked to Arthur Clarke. We had a couple of long conversations on the phone.

Weber: At the time or later?

Abramson: Oh, well this was well after he had started writing stuff after he had done 2001 and in fact he had one of the conversations was after—when he had just done 2010 I think, the second—another version of 2001—and he asked me what I thought of it, and I had seen it. I didn't think it was anywhere near like 2001, and so I tried to put that in the best pace—face forward 'cause I have an enormous respect for the guy. I didn't want to say, "Oh, your movie wasn't as good as your other movie" but that's basically what I had to tell him, but of course 2001 is a—is an achievement hard to match.

Weber: Where did you go from Hughes? How long did that last?

Abramson: You mean the UCLA thing.

Weber: You were at UCLA at the same time that you were doing the fellowship with Hughes—

Abramson: Yes.

Weber: —but Hughes was a year. Right?

Abramson: Hughes was a two-year fellowship and the course load at UCLA was sort of a half course load so it took me two years to get my master's, and then what I did is I applied for a Ph.D. and I decided to go to Stanford.

Weber: Your work at Hughes was for course credit as well or not?

Abramson: My work at UCLA was course credit for—it was a standard master's in physics program except it was only at half speed.

Weber: The work at Hughes was not counting for course credit toward—

Abramson: No.

Weber: —two separate—

Abramson: Two separate but related activities.

Weber: Tell me about UCLA.

Abramson: UCLA—I did not immerse myself in UCLA as much as I did at Hughes. I did well enough and enough to get a fellowship at Stanford but I probably just didn't get involved because it's hard to get involved—I find it hard to get involved as a—sort of a commuting student. I wasn't living there, I wasn't part of the scene, and so I enjoyed it but I decided that I would switch to engineering rather than physics because I enjoyed the stuff I was doing at Hughes Aircraft a lot more than I was my degree activities at UCLA.

Weber: Where were you living at the time?

Abramson: Well, I had just got married, which of course affected my life to a great extent, and I was living just north of UCLA campus in a small—on—oh, let's see—one of the small canyons that goes up north of UCLA.

Weber: You met your wife there or—

Abramson: I—gosh, I met my wife in Baltimore when I was an undergraduate at Harvard, and then we didn't see each other until I got to UCLA and then she was still at UCLA, and when I was getting my master's in physics she was getting her master's in journalism and actually she got a master of science in journalism; I got a master of art in physics.

Weber: Where did you learn to surf? Was that in that period?

Abramson: Oh, no, no. I didn't ever surf until I think I was 33 for—the first time I surfed. I did a lot of swimming in the ocean in Boston but of course it was as a kid and I was—I could tolerate the cold Boston waters, but surfing came a lot later in my life. It came with a great amount of interest but I didn't get on a surfboard until I was 33.

Weber: We'll get to that.

Abramson: Okay.

Weber: You decided to go to Stanford for—

Abramson: I decided to go to Stanford in electrical engineering and I was lucky. I had the nicest guy you would ever meet, Bill Harman, as my adviser and then he became my thesis adviser and then he became my thesis adviser, and I was much too cocky when I came in to Stanford. I thought I knew everything. Bill tolerated that very nicely I—probably better than I would have tolerated it with a student who came in when I was teaching, but he showed me the ropes both in terms of courses and in terms of just the social aspect of learning to live with a bunch of high-tech people 'cause I had no clue.

Weber: From Hughes and UCLA?

Abramson: I don't know why I didn't pick it up at Hughes; I didn't. I didn't pick it up until I went to Stanford. I managed to survive at Hughes without getting into any real problem probably because I was only half time there and I probably also didn't have any trouble at UCLA 'cause I was only half time there, but if—I think—if I were full time at either place I think the social part of it was beyond me and I—I'm glad I was able to skirt it by being half time. And I learned a lot from Stanford both in terms of engineering and socially.

Weber: What did you learn socially?

Abramson: To pay more attention to other people, to—I tried—probably—some of my friends may say I still could use a few lessons in it but I tried not to be too self-absorbed and interest in other people and what they're doing has—that was probably something which Bill Harman and the surroundings at Stanford did for me that I'm very grateful for.

Weber: How did they nudge you in that direction?

Abramson: I think just living there and participating full time with a bunch of pretty neat guys, Bill and some of the faculty then, especially the under faculty at—in those days at Stanford and the general maturation that occurred. Perhaps in my case it didn't occur until I got to Stanford but I really felt like I didn't become an adult until I was around 23 when I got to Stanford and started to become adult. I really felt before that time at UCLA, Hughes and Harvard too much like a sophomore even though I had a wife and one child—actually by the time I got to Stanford we had two children.

Weber: At 23 so—

Abramson: At 23.

Weber: Was it two?

Abramson: No. I'm sorry. That was not true; it was one child still.

Weber: That's still a lot.

Abramson: Shortly after Stanford there was another one.

Weber: Did your wife do something at Stanford or she—

Abramson: Yeah. The top newspaper in the peninsula in those days was something called the Palo Alto Times.

Weber: I grew up in Menlo Park—

Abramson: Oh, okay. Well, the Palo Alto Times was a pretty good newspaper in those days. I notice that it's disappeared sort of, I don't know what happened, but when she was there she was writing for the Palo Alto Times as a stringer and she was also an undergraduate in history it turns out—I'm sorry—a graduate student in history at Stanford but that didn't strike her—didn't last very long, about a year or so. She mostly worked as a journalist.

Weber: Were you living on campus then or—

Abramson: No. We were living in east Palo Alto. We bought a little house in east Palo Alto and—about a mile or two up the street and went to Stanford.

Weber: What were you working on for your Ph.D.?

Abramson: For my Ph.D., I—well, one of the things that—one of the areas where Stanford helped broaden my outlook was I took some courses outside the electrical engineering department, which was pretty unusual in those days, in the physics department—I'm sorry—in the statistics department, which was pretty strong in those days. There were some really very inspiring younger teachers then, Manny Parzen and Sam Karlin are the names that I remember, and I took some courses in statistics and some—a new pit of that called decision theory and game theory, and got into those two areas, especially decision

theory, and used that as part of my—as the basis of my thesis in electrical engineering. I applied decision theory to certain kinds of measurements that you take in communications and did some sort of interesting work on that, and I wasn't convinced it was interesting until about 20 years later when I found out that Claude Shannon at about the same time had been at Stanford at an institute there, not at the university, and had written a paper in essentially the same area which somehow didn't get widely distributed. I didn't know about it until 20 years later, he didn't hear about my thesis at all, so it was too bad that we didn't connect; I wish we had connected at that time.

Weber: Can you summarize the—

Abramson: Well, it's a paper that has interesting theoretical consequences but I can't say that it had really led to anything in the real world. It—it's called comparison of experiments traditionally in—by statisticians and it essentially says "What do you want to measure to do certain things?" And for example one of the things that I could show is that the more energy you received in your signal the better off your decision could be made, not very startling but nevertheless I proved that and—through this comparison of experiments stuff that I worked on and I also proved some other stuff which wasn't as obvious but doesn't seem to have led to much.

Weber: But by this time you thought of the theory of communication as your main—

Abramson: Yeah. By this time I was starting to teach the communication theory at Stanford—taught information theory at Stanford and one of the things I think I did well then is I learned an awful lot by teaching. I didn't know either of those areas as well as I should when I started teaching but in information theory I ended up writing a book which is—had a certain amount of success and was published in a number of languages and lasted pretty much until a student in my class wrote a book which is much better and his book became the standard in the area.

Weber: Which student?

Abramson: Tom Cover. And in communication theory I—basically I worked in that area, not information theory, for the next 20, 30, 40 years, still doing some stuff there now.

Weber: I read that some of your early work was radar signal characteristics and sampling theory but that would have been back at Hughes.

Abramson: Part of that was at Hughes. Part of that was part of my thesis because the radar question is "What do you want to measure?" and the—what I showed for radar was that you simply want to measure the energy, you don't have to measure anything else, and the higher the energy the better the decision.

Weber: This was for your Ph.D. thesis.

Abramson: For my Ph.D., yeah.

Weber: It sounds like a lot of frequency modulation, digital communication, error correcting, all of this you were—

Abramson: Yeah, that communication theory—I was having fun in all that stuff for the next—until I started working on the ALOHA network.

Weber: Were you seeing this as the channel was unimportant; this was just the theory of—

Abramson: No. I just saw—the way I did it is that I tended to concentrate on things which were simple but unknown and I did—I hit upon lots of interesting problems I think in great part because I was always connected to a real-world problem. I was connected that way at Hughes when I started working on what I did there, and then shortly after I got to Stanford when I was still a graduate student I was asked to consult with the people at IBM down in San Jose, did some consulting there for Ray Johnson on a system which you guys must have here called RAMAC, the random access disk, and that led to some work on coding theory on my part, which turned out to then lead to some patents which I did with IBM, and it sort of snowballed from there and I did a lot of interesting stuff for me in codes and in applications of coding to in those days random access memory but also it turned out to channels—communication channels.

Weber: Beyond memory like the RAMAC, what were the specific applications?

Abramson: Well, at IBM it was all in the codes, and I patented a version of the standard code that was known in those days, the basic building blocks of almost all codes done by a guy named Dick Hamming, Hamming codes. I found a version of that which were what are called cyclic, which made them a lot easier to implement, and then which led to a whole bunch of other codes which were then easy to implement, one of them in a thesis that I supervised at Stanford by a guy named Phil Fire called the Fire codes and—but—which by the way was probably the most important thesis I supervised at Stanford but it was not a Ph.D. thesis; it was for the engineering degree. And it would have been a great thesis for a Ph.D. too but somehow he didn't want to do that.

Weber: You were doing consulting on these as you were beginning to teach.

Abramson: Yes.

Weber: What year did you get your doctorate?

Abramson: My doctorate at Stanford was '58.

Weber: You were—

Abramson: And I stayed on at Stanford as an assistant and an associate professor until I first tried a surfboard.

Weber: Tell the story of that. After your doctorate—

Abramson: Well, I was teaching. I enjoyed teaching at Stanford. I mean the greatest part of teaching at Stanford, at least in those days and I suspect today, is the tremendous wealth of graduate students that you get to work with. The graduate students—you can get some really good graduate students at other places too but if you're talking about the large numbers of really bright graduate students in those days Stanford was the place to be; I suspect it's not changed that much. And I had a great time doing that and the—I think it was probably in the early '60s I was giving a paper in Tokyo and I—in those days the planes from here to Tokyo—from the Bay Area to Tokyo stopped in Honolulu, and so I got on a plane and had a one- or two-hour wait in the Honolulu airport, looked around and said, "Gee, this is a pretty nice place," went on to Tokyo, gave my paper. And on the way back I changed my flight so I spent three or four days in Honolulu and I rented a surfboard at one of the few hotels on the beach at Waikiki in those days, the Moana, I got on, I learned how to surf, and I said, "Boy, I could stand some of this." And I went over to the University of Hawaii, talked to the people there, and it turned out they had some job openings and I said, "I'll think about it" and went back to Stanford, and about a year later I was teaching at the University of Hawaii and surfing every day, not teaching every day; I was surfing every day.

Weber: We both know there is surfing in Santa Cruz as well.

Abramson: Yeah. I've tried surfing in California too. I've gone down to San Diego. You have to surf with a wet suit. I've never surfed with a wet suit. I surfed from the first day I got to Honolulu when I started teaching there for about 30 years and I never needed a wet suit. The water was always warm and the waves were pretty regular and sometimes they were really big and I enjoyed it. I always had the feeling that if I didn't take that job I would 30 years later look back and say, "Gee, Norm, I wish you would have taken that job."

Weber: How did your family feel about going to Hawaii?

Abramson: My kids were a little put off by it. They weren't sure what language one spoke in Hawaii in those days because the jet planes had just come in before that period. This, remember, was early '60s; there were mostly propeller planes that you had to take to get there or the ship. And my wife found a job teaching at the university too in the English department and in journalism and then—so part of a longer story—this was now the early '70s—she filed one of the first sex discrimination suits against the university for sex discrimination and won, and that caused some interesting political things at the University of Hawaii.

Weber: Because they hadn't promoted her or they—

Abramson: It was a tenure issue and—where—and it was quite common in those days and it was pretty much accepted that males would be tenured and the females would be put on part-time non tenured positions usually paying a lot less, and somehow those of us who lived in those times didn't think this was so bad and we sort of thought it was the way the world worked and my eyes were opened pretty quickly.

Weber: You had tenure by that—

Abramson: I had tenure, yeah.

Weber: Was the fact she was married to a tenured professor irrelevant or—

Abramson: It seemed to be irrelevant and exactly what— she wrote two books about it and—because she—this became a pretty—a national case and she became pretty well known for this kind of stuff.

Weber: When you first went there, talk about what it was like to go from Stanford to Honolulu.

Abramson: Well, I think I said this a little bit earlier, but at Stanford one—the thing I missed the most was the large number of really great graduate students, but at Hawaii we got a few of those people, not all—not as—nowhere near what you got at Stanford, but the peaks were about as high as they were at Stanford. Think of Charlie Bass for example who worked in the ALOHAnet and started Ungermann-Bass and John Davidson who did that with him, people probably well known to the museum, and they were all Hawaii students.

Weber: When you first got there you were kind of looking for a project as I understand. Tell me about THEMIS. Is that pronouncing it correctly?

Abramson: THEMIS? Yeah. Well—

Weber: How did that come about?

Abramson: I was moving towards computers. The last few years at Stanford I learned how to program, learned how to program because my cousin was a programmer for an army computer, and one day when he was over at the house I said, "Hey, why don't you show me how to program" so we sat down in the living room for an hour or two and he showed me how to write a FORTRAN program, and that was my beginning and I did a little bit of that at Stanford. I also took that to Harvard because I went from Stanford—before I went from Stanford to Hawaii I decided to spend a year at Harvard so I went to Harvard after I decided to leave Stanford and spent a year there teaching, and I taught the first general education program at Harvard to use computers. This was a course in information theory for nonscientific types. This was—just like I had to take a course in philosophy, the philosophers had to take a course in science, and the philosophers would—and the social scientists and the humanists would take this course. I gave this course and there were a lot of them in there, it was a pretty large course, and I had them all writing programs and doing computers in that undergraduate course at Harvard, which was—I—I'm pretty—which was—I know was the first non science course to use computers at Harvard. So that's where the programming in my case started, the interest in programming, and I knew that computers were going to be important. I knew that I was in communications, and I had a background there and I was trying to find a way to use my communications background connected to computers.

Weber: What sorts of things did you program?

Abramson: Well, you mean in the course at Harvard?

Weber: You say you started to—

Abramson: Oh.

Weber: —write code.

Abramson: Frankly, I can't remember what they were. They—probably they were just calculations of performance and things of that sort, which are standard things to do in communication theory. At Harvard I had the students do some programming for coding and for various other kinds of very simple things but nevertheless they were programming.

Weber: When you got to Hawaii what were you hired to do?

Abramson: I was hired to do communication theory and electrical engineering, and the year that I got there—or the year before I got there Wes Peterson who is quite well known for coding got there, and then the year I got there we hired about three or four other people in communications including Ned Weldon, the year after I got there Tom Gaarder, Frank Kuo, and we had a pretty good group. And then the Department of Defense—so it was after I had gone to—after I had been teaching at Harvard and come to the University of Hawaii, the Department of Defense announced a program called THEMIS which was essentially a political response to provide support for non top-tier universities in providing them with research support the way Stanford, Harvard and MIT would get research support. Hawaii and other state universities rarely got such support and I suppose that led to some political pressure in Washington, and I don't know about the political pressure but I do know the result was THEMIS, which is essentially advertised by the Department of Defense as research support for underdeveloped universities.

Weber: You were talking about THEMIS, its purpose for second tier—

Abramson: Well, no, <laughs> developing universities, and it was a great chance to provide good research support for all of the new faculty that had come in just the year that I came to the University of Hawaii, and we all thought about it and it was sort of a natural. We were interested in communications. Some of us—well, Wes Peterson who was involved in it was the director of the computing center and I was certainly interested in computing and communications and computing was an issue. People were stuck with telephone lines into mainframes as the only way to connect in those days; clearly, that wasn't the good way to do it. We thought about it for a while and came up with gee, this is a military budget, obviously they would be interested in radio communications into a computer, and so we took a look at it and said, "Fine. Let's research radio communications into a computer" and that's what we—we proposed a project to do that and the project was approved by DARPA.

Weber: But it started with THEMIS under DOD and also on your paper from 1970 they're listed as one of the main sponsors of ALOHAnet.

Abramson: Oh, yes.

Weber: It started as a pure DOD thing or you—

Abramson: It started as a pure DOD thing but the way DOD worked that particular program they assigned THEMIS—see, THEMIS was basically a line in the budget. They assigned THEMIS projects to various supervising agencies. In some cases it was ONR, in other cases it was AFOSR, and in our case they decided to assign us to DARPA, at that point it was called ARPA, and probably the reason for that is that I had gone in and talked to Bob Taylor.

Weber: That was before, and that was the story I wanted to ask you about. How did you know of Bob first?

Abramson: I was—

Weber: You knew someone in common. Right? The year that I was at Harvard I was asked to be part of a DOD study group on multiple access. There were four—maybe six—six or seven of us I think. Among the people in the study group there was Andy Viterbi, Irwin Jacobs started Qualcomm with Andy, and Joe Aein who was working as a researcher in another Washington agency at the time. Joe I recall suggested I go in to ARPA and talk to Bob, Bob Taylor, because I was going to—by then I was going to Hawaii when I was in this summer study group, and we were looking for support and he thought that Bob Taylor would be a good person to talk to and in fact he was. I talked to Bob and Larry Roberts at that time and that basically led to their support of our proposal in THEMIS.

Weber: Describe your first meeting with them.

Abramson: Well, my first meeting with—was with—I went in to Bob's—Bob was the director of the office. He had me talk to Larry first and Larry and I didn't hit it off at first. I had the impression that Larry was looking down at the University of Hawaii, and I don't know if that was true or not but I sort of took umbrage at that and let Larry know that I took umbrage at it; I wasn't too tactful. In any event, before the end of that meeting we were joined by Bob Taylor and Bob saw what was going on and he calmed both of us down. Larry is probably not as forgiving of things like that as Bob was, and in any event the point of that whole thing is Bob set things right and Larry and I have been really very close all the way through the ALOHA project and the—although our first meeting didn't go very well our subsequent meetings went very well.

Weber: It was just the first meeting?

Abramson: Yeah, it was just the first meeting and it—probably I was hypersensitive because I had been—I'd taken the big step of leaving Stanford and Harvard and going to the University of Hawaii and I was a little worried about what that would mean to my career and—

Weber: Do you remember what you said or—

Abramson: No, I—it was trivial stuff and it was—probably I was overly sensitive and Larry was simply making some comments on the fact that well, the University of Hawaii isn't MIT and that was enough to set me off.

Weber: You told Jim Pelkey 20 years ago now that you had been not defensive but offensive.

Abramson: Yeah, I probably was not as socially adept as I should have been but Larry is not that socially adept either so that was fine. <laughs>

Weber: Bob smoothed the waters.

Abramson: Bob smoothed the water. He was always socially adept, and Bob saw what we wanted to do and I think Larry did too and they supported what we were proposing very strongly.

Weber: And they told you about ARPANET then I assume.

Abramson: Yeah, that's right. I came in to talk about ARPANET in fact rather than THEMIS. I wanted to find out what they were doing, and they did explain what they were doing on ARPANET and I thought that was neat stuff and I figured that sooner or later I'd get involved.

Weber: They were the supervising agency of the THEMIS grant in a sense or they were administering—

Abramson: That's right, and so Larry would—he was I think—he had the responsibility of supervising the grant and he had control of our budget but, unlike any other person in that kind of administrative position that I've ever known, Larry not just helped us in terms of the administrative effect but he participated in the research of our program to a very significant degree.

Weber: We'll get to that as the time goes—

Abramson: But he was that kind of guy and he is that kind of guy.

Weber: How connected were you with what they were doing with ARPA? You knew about some of it obviously, some of the people came out, but you weren't regularly exchanging information or were you?

Abramson: You mean when I first got to the University of Hawaii?

Weber: Yeah. As you were beginning what became ALOHAnet, that's around the same time ARPANET was really ramping up. How much contact was there between—

Abramson: There was a good amount of contact. I would see these guys at various places. Len Kleinrock was involved at that point and I had known Len from other things at UCLA and so there was a good amount of contract (sic) in usual scientific and engineering meetings, but the contact of course solidified and became very important with the THEMIS program. When we applied for THEMIS they supported that and ended up supervising the THEMIS effort.

Weber: From that meeting, that's when really ALOHAnet started in a sense?

Abramson: That's right.

Weber: Take me through that.

Abramson: Well, what we did is we—our proposal was to examine and try to define those areas where radio communications would be preferable to conventional wired communications, and conventional wired communications in those days was essentially dial-up connections to a computer and we're just starting with ARPANET a connection using 56 kilobit lines to connect interface computers called IMPs, interface message processors, to connect different computers at different universities and at other locations. So the connection with ARPA was probably—we were aware of us and they were aware of them until THEMIS started and then we were very close specifically 'cause—and Larry took over Bob Taylor's job as director of that office of ARPA.

Weber: But you had already decided to study using radio communication computers before the THEMIS—

Abramson: Well, we thought that—that was sort of a—one of a number of things that we were thinking of as good projects to work on. I was also doing some other more theoretical stuff at the time, some of it coding, some of it in communication theory. And that wasn’t the only effort that I had. But as soon as THEMIS was approved, basically, all of my effort went to trying to find a way to connect—to set up wireless data networks. And I don’t think I really understood how big that was going to be. But I knew it was going to be important, and certainly had obvious importance for the military. And it looked to me like it had some importance to satellites as well, which are becoming available in those days.

Weber: And so in Hawaii, tell me about the other people involved and kind of who did what.

Abramson: Well, Wes Peterson was probably the person who was—on the faculty, who was most involved beside myself. Wes was director of the computing center, and therefore he controlled access for us, luckily, because he was always very supportive and very helpful. But getting into the—we interface to an IBM computer. And interfacing to an IBM computer by radio had not been before. And so, the whole

question was how to do it. And Wes suggested, at that time, he had what was essentially a super A to D converter, analog to digital converter, which interfaced to that IBM computer. Since it was an A to D converter, we could take any signal, which was analog, and make digits, make bits, out of it. And that’s the way we interfaced to the IBM. Now, it’s a very inefficient way to do it. It was a humongous big machine, this A to D converter. But Wes controlled all those resources, and he thought it was interesting. And so, we arranged to connect to the IBM 360 through the University of Hawaii A to D converter.

Weber: So, you would take the radio signal and simply feed it in as an analog signal—

Abramson: Yeah, the received radio signal then would be put into the A to D converter. And then we’d get bits out. And that’s when things became easy.

Weber: And you were the principal investigator?

Abramson: I was the principal investigator of the—we called it the Aloha Project, or the Aloha System. And I guess I was for every year except one or two when Frank Kuo took over that job. And Frank and I were planning to just alternate—I don’t recall whether it was on an annual basis or a biannual basis. But neither of us wanted to do it full time, and that was the way we came up to a modus operandi.

Weber: So, the A to D converter is almost the first step, right?

Abramson: It was the key which allowed us to connect to a digital computer from radio waves. I probably underestimated how difficult that task would have been without that A to D converter. With the A to D converter it was great. When I wrote the proposal, I don’t think I had the A to D converter in. I just said we’ll connect radio to the computer and probably didn’t have a good enough understanding of the hardware limitations.

Weber: And what sort of budget?

Abramson: It was the largest project that the—the largest research project at the University of Hawaii for several years. I don’t really know the budget. There is a document which is the final report of that project, which is I think available on the web. And I can get that for you also if you’d like me. I have three documents I’ll send you right now.

Weber: And so, you began to hire people, though?

Abramson: We began to hire people. Of great help in hiring at that point was another one of the faculty members who’s since become well known. And that’s Ned Weldon. Ned had a lot more practical experience than I did. He had actually built things. I had never done that. And he was in touch with some very good students who, in part, he had trained. And he steered them to me. And we got some very talented people. I can think of our digital guy was Alan Okinaka. Our radio guy was Dave Wax. Our software guy, our protocol guy was Richard Binder. And the fourth key person, and these are all students now, was Chris Harrison, who partway through—came on later, part way through the project, because at that point he was familiar with a new device which had just come out, the microprocessor. And he said how about using the microprocessor to do some of this stuff. And so, he was very helpful in that respect.

Weber: And so, how did—talk about coming up with the basic design for the system.

Abramson: Well, the basic design was worked out a meeting that I would call these things weekly or biweekly meetings where we would talk about how to design the network. And I recall at one of these meetings we batted around there were all sorts of possibilities. We could have tried for some sort of frequency division or time division multiplexing, or time division for access. We could have looked for something like code division multiple access. And we thought about all those possibilities. But most of the possibilities looked pretty inefficient in terms of the kind of traffic that was being transmitted from terminals. And CDMA, which wasn’t inefficient, was just too difficult to build in those days. This was 1965. I’m trying to think about this. Yeah, around 1965, ’66, coming up to 1970, that late 1960s. And CDMA was just not practical in those days.

Weber: Because you moved to Hawaii which year?

Abramson: Around ’65.

Weber: Right, and your meeting with Taylor and Roberts was like ’68?

Abramson: It was before I got—my first meeting with them was before I got there. But probably was about a year or so after that before the THEMIS activity got going.

Weber: So, this would be ’67—?

Abramson: ’67, ’68. Around that time, we started thinking about possibilities. And the basic mechanism that came out of those meetings was sort of we looked at all of these other sophisticated possibilities. For one reason or another, they seemed impractical. And so, we said, “Oh, hell. Let’s just transmit packets. And if we don’t get them, we’ll repeat the packets.” Oh, well. Okay, we’ll do that and see if that might work. And basically, it was the simplest thing you could think of. It was not efficient, but it was simple. And

I’ve since learned that simplicity has a great reward if you keep your eye on the ball. And Aloha is about the simplest kind of protocol you could imagine. You have multiple transmitters. Each one of them transmits a packet of data whenever they want. And so, there’s always a possibility that two will decide to transmit at about the same time. If they do, you can’t receive them, usually, at the receiver. So, you have to retransmit them. And you retransmit them at random times.

Weber: And the idea of using packets for this, I mean that came from the ARPA crowd?

Abramson: Yeah, well even before the ARPA crowd, Paul Baran—

Weber: I know. But I’m saying for you, how did you—?

Abramson: I knew about Paul’s work. Yeah. I had read some of his stuff on hot potato switching and that. And so, Paul had really started that whole idea. I look on Paul as the father of packets. The ARPA crowd took it way beyond that. And I think, like a lot of us, probably took it before they had completely absorbed all the work that Paul Baran had done. But they did it well. And they did it right. And they solved the right problem. And so, we took off from an existing operating ARPAnet with IMPs, imps, interface message processors, connecting different resources.

Weber: By the time you actually started operation, but in ’67 or eight when you’re conceptualizing it, you were—I mean you were sure you wanted to use packet switching based on—

Abramson: Yes. The ARPAnet was already working while we were having these meetings. So, we better look at the—

Weber: So, it was a little later, then.

Abramson: Yeah, it may have been a little later. But it was—it had to have been no later than ’68 because by ’70, we had a network in operation.

Weber: Right. I mean they were testing it all out a BB&N and that kind of thing. It was well underway.

Abramson: They were testing it out. And Len Kleinrock was measuring stuff. And so, there was stuff going on. And it was interesting, important engineering work.

Weber: So, tell me then what’s on—so you have the 360. And you have a way to convert to radio waves. But then what were you transmitting to? Describe the rest of the system.

Abramson: Well, what we were connecting were the terminals available in 1970. Those terminals were mostly Teletype machines. Nobody knows what a Teletype machine looks like anymore. But you probably have some here. But outside of museums, there aren’t anymore Teletype machines. But that’s all we had. And then a little later, not too much later, we were provided with what were called dumb terminals. They were terminals that could display characters on a screen. But, of course, they didn’t have a microprocessor. And so, you had to do all of the work in determining which characters go where before it got to the dumb terminal. But it was a big step up from a Teletype machine. For one thing, it wasn’t noisy. And for another, it worked a lot faster.

Weber: And you connected forty users around the islands, right, eventually?

Abramson: We eventually had—I don’t think it was as much as forty. I would say that the peak number of users we had at any one time was probably twenty, twenty-five. But then we had a few other devices that we connected, too. We had packet repeaters. And we had sensors. So, there may have been as many as thirty to forty separate devices. But in terms of just terminals at which people could work, maybe twenty to twenty-five.

Weber: And there were no other computers connected, or were there?

Abramson: Well, initially, we just operated a wireless data network into the University of Hawaii’s computer. Very quickly though, we started to connect other things. Do you want to get into that now?

Weber: If you maybe chronologically, let’s go through them.

Abramson: It fits pretty well. The first thing that we connected to was the ARPAnet. The ARPAnet was now starting to grow. There were ten, twelve different computers connected to the ARPAnet. And people—lots of people wanted to connect to the ARPAnet. We thought that we ought to be connected, as well. But, of course, nobody was going to run a 56 kilobit cable from our computer to an IMP on the mainland. That was going to be too expensive. At about the same time, Comsat when into operation, and in particular they had launched a satellite which was digital. But their only offering was not 56 kilobits, but was 9600 bits per second. Now, the way they did that was they would take your 9600 bit per second signal and convert it into a 56 kilobit and then a 64 kilobit signal, which went over the satellite, and then reconvert it down to a 9600 bit per second signal. Not very efficient, but it did the work. We wanted not 9600 bits per second; we wanted 56 kilobits. And so, Comsat proposed that what we do is we put together some number of 9600 bit per second signals, that is we convert our 56 kilobit signal, which we wanted to transmit over the satellite, to I don’t know maybe it was eight 9600 bit per second signals. And

then they would sell us eight channels. Each of them would be converted to a 56 kilobit signal in the satellite and the down to California. And then they would take all these bits and convert them back to a single 56 kilobit signal. Well, it was great for Comsat because in order to transmit our 56 kilobit signals, they got to sell eight 56 kilobit channels instead of one. Larry Roberts heard about this. And Larry’s pretty good at dealing with organizations like that. I wasn’t involved. But by the time we were ready to actually connect to the ARPAnet from Hawaii, Larry had managed to negotiate a 56 kilobit tariff from the Comsat people. Showed up for years in the Comsat annual report as the ARPA tariff. And what it did, it allowed us to give them a 56 kilobit signal directly to their Earth station. They would transmit it on a single 56 kilobit channel and deliver it to the user, namely ARPA on the mainland. And it worked fine. But that’s one of the talents that Larry had. He really knew how to deal with large organizations. He had to do that with AT&T. He did that with Comsat. And that’s one of the main reasons for the success of ARPAnet.

Weber: Yeah, and his managing to get leased lines at competitive rates.

Abramson: It wasn’t really a commercial thing. It was a real talent of technical persuasion on his part.

Weber: And they were—particularly AT&T was not friendly to packet switching.

Abramson: Yeah, AT&T was sure packet switching wasn’t going to work. They weren’t malicious or malevolent. It wasn’t in their interest. But the reason they thought it wasn’t going to work is they thought it wasn’t going to work. And Larry got through all of that mess. I don’t know how. I wasn’t involved. And I didn’t want to be involved. But he came out at the end of both of those kinds of negotiations with AT&T and then with Comsat with the right answer.

Weber: But you were connected through, over a satellite, to the ARPAnet. But within the Hawaiian Islands, were there other computers on other islands connected into—?

Abramson: We did have terminals on other islands. And we had sensors on other islands. We were, for example, measuring the wind velocity at the top of Haleakala for a while and transmitting packets back to Oahu and the Alohanet on Oahu. And we talked about a computer connection to the Hilo campus on the big island in Hawaii. I’m not sure if that was ever put together.

Weber: But effectively, it was the 360 that was the ARPAnet node, then? And it had an IMP that was connected to the—?

Abramson: What we did is we had a slightly different version of an IMP, which we called a satellite IMP or SIMP. And the SIMP was our connection to the ARPAnet.

Weber: And who developed that?

Abramson: BB&N did. It was not a major task like developing the first IMP. But it—they just couldn’t use a regular IMP. There had to be some modifications. I believe there were software modifications.

Weber: So, you worked with Frank Hart on that?

Abramson: Frank was a key person in getting a lot of this going. And he was another very talented guy in making things work.

Weber: But you dealt with him mostly around connecting to the ARPAnet?

Abramson: Yeah, but he was also a good guy to have a beer with.

Weber: Oh, yeah, yeah. But I mean he was not involved with—BB&N was not involved in designing the hardware for Alohanet?

Abramson: No. We had our own hardware group because we were doing something fundamentally different. We were doing radio—or wireless data networks. And nobody else was doing that at that time.

Weber: And one of the reasons that you’ve given in other interviews for doing the wireless is that the—using wires in Hawaii was simply not feasible.

Abramson: Well, it was poor quality. Hawaiian Telephone Company at that time was a stand alone company. They were subsequently bought out by GT&E. And they were strengthened technologically. But when we first started, there were some connections for computers in Hawaii. This is the timeframe ’65 to ’70. But the quality was poor. The cost was high.

Weber: And then so you hire—mostly it was students though that were designing the different parts of the system.

Abramson: Yeah, the faculty involved were myself, Wes Peterson, Frank Kuo, Ned Weldon, and Tom Garter.

Weber: Talk about Frank Kuo’s role.

Abramson: Frank was—he was the director for either one or two years. I forget which. And I took a sabbatical for one of those years, if it was two. I think it was—it must have been two years because he was director when I was back also for a while. And he interfaced directly with, I think it was, Bob Kahn at that point who had taken over the office. But Frank was one of the people who came in the same year that I came in and that Ned Weldon came in.

Weber: You had mentioned another—you've talked about Ned Weldon. You've talked about—there was another fellow that—

Abramson: Oh, Tom Garter?

Weber: Yeah.

Abramson: Tom was a former student of mine at Stanford, actually. He got his PhD with me at Stanford, one of the last I did there. And then he went to Cornell. And I managed to convince him to come to Hawaii from Cornell about two years after we—after I got there, which had to have been maybe '68, '69, something like that. And Tom is still there.

Weber: And the components of the system as it evolved were, obviously, the A to D, and then you have pictures of some of the—

Abramson: Yeah, I have some pictures. And they're in that last article that was published in December of 2011 of what we called a terminal control unit, a TCU. And the TCU was the box that you connected through and RRS 232 interface to the dumb terminal, either a Teletype or a CRT terminal. And from there, it had a little radio in it. And you transmitted bits at 9600 bits per second all through any place that had connection to the Minoa campus, which was a good part of the island of Oahu. And it was—I didn't realize how impressive it was at the time. But we had visitors every so often. And it was pretty impressive because it was reliable, fast 9600 bit communications for a large number of users. And that wasn't around in 1970.

Weber: And you could move around with your terminal, obviously.

Abramson: Yeah, I mean it was too big to carry, but you could move it around. But it wasn't portable. Although, a few years later, I don't know if you've seen this picture also of—

Weber: Seven hundred?

Abramson: What’s that?

Weber: Silent seven hundred, no?

Abramson: No, what I did is I took an HP 65, which was the hottest hand held computer in those days, and I just took an automobile antenna. And I just held on the back of the HP 65 so I had this little square unit with an antenna coming out of it. And I have a picture of myself holding that in front of Diamondhead from must be around ’75. But I’m pretty proud of that because it indicates, this was before any of this stuff of wireless data networks was around, and certainly before any 1G, 2G, 3G, or 4G networks. We had a pretty good picture of what was going to start. I mean—once we had built and saw how well what we built worked, we knew this was going to be very big. What we didn’t want to do—what I didn’t want to do was to get involved in the negotiations with FCC, with AT&T, with all the other groups that were needed in order to make this into a reality.

Weber: Now, Larry Roberts did the paper in ’72 on the hand held terminal.

Abramson: Yeah.

Weber: Was there any coordination on that?

Abramson: No, there wasn’t. But he did that paper in ’72. And I guess he could see as well as I, then, the future of what we were doing.

Weber: But his was specifically a terminal. Were you thinking telephony, as well, or terminal, or unspecified?

Abramson: Once you can hold an object in your hand which can be connected at a pretty good data rate to a central station, and you can connect a lot of them, and that’s the key point, you can do it for not just one, but multiple numbers of users, I think it was clear to all of us it was going to include voice. It was going to include all kinds of data, Internet access. We didn’t know how the politics of it would work. But we know it would work. The technology would work.

Weber: And maybe this is probably a good time to go back to Larry. I kind of cut you off. He was not just a funder, but also a contributor, researcher.

Abramson: He was also a major contributor.

Weber: And he came up with the idea of slotting, I believe you said.

Abramson: Larry came up with slotting and also with the idea of the capture effect, using that, which helps—

Weber: Describe that.

Abramson: What’s that?

Weber: Describe the capture effect.

Abramson: The capture effect simply says if you get two signals coming into a receiver, they both interfere with each other. And you can’t receive either one. Now, in FM the capture effect can help out in that situation. If one of them is a little bit bigger than the other, you can catch the big one and suppress the small one. Larry said we could do the same thing in Aloha. And he was absolutely right.

Weber: So, if one was stronger, then you would—

Abramson: Okay, go ahead. I’m sorry I missed.

Weber: So, if one was a stronger signal, you could simply squelch the other one?

Abramson: Yes, exactly. So, you see what our model said is if two people transmit at the same time, you lose both signals. Larry said no. It may not be that bad. And it wasn’t.

Weber: Right. And the raw beginning protocol you had eighteen percent throughput, something like that.

Abramson: Right.

Weber: The slotting brought it up to—?

Abramson: Thirty-six percent.

Weber: And with the capture effect, then—?

Abramson: Depends on certain characteristics of the capture effect, you can’t give a good simple number for that. Also, you can’t really say that slotting is always the way to go because you get twice the throughput. This is a mistake that some people in the early days, and in fact even recently, make. There are certain assumptions about slotting, namely that all the packets are the same length, which is often true. But if it isn’t, and if it’s seriously not true, then slotting can hurt. And one has the question with sort of a Shakespearean cast to it, which we talk about sometimes, to slot or not to slot, that is the question. Sorry about that.

Weber: So, do you remember when Larry came up—proposed slotting?

Abramson: I don’t remember, but there is a famous paper that he wrote which he never published but somebody else published for him. And it stated, and I would guess it would be probably ’71, ’72, but I’m not sure.

Weber: But I’m also asking do you remember the circums—how did he tell you about it? How did he come up with it?

Abramson: I was in the ARPA office one day. I remember very well. And Larry and I often talked about some of the technology things. And he said I’ve got something I’d like to show you. And I sat down at a table with Larry. And he described slotting. And I said sure. That’s great. And he showed his calculation. And I thought it was fantastic. And then at the same time, he said also I have this other thing called capture effect. And he explained that. And so, it sort off rolled off Larry quickly. And both of those were important developments.

Weber: And so, then you went back and told all the team.

Abramson: Told the graduate students. And a lot of people started working on that, including me, did some paper which involved some of the slotting stuff.

Weber: And it got incorporated quickly into what was effectively the protocol?

Abramson: Well, we never incorporated slotting in the Alohanet because we had the situation where packets, in fact, did have different lengths, and vastly different lengths. And it appeared that you would lose as much by slotting as you gained by the factor of two. But the first mobile phone that was put together used Aloha—this is 1G phones, now, way, way back. But it used Aloha for the control channel, that is the signals which would come up to connect you to the network and do other network operations were Aloha signals. And they used a slotted Aloha channel for that. And so, the telephone industry now uses slotted Aloha primarily, although not exclusively.

Weber: And it’s that control channel that was also later used for text messages, right?

Abramson: That’s right. That’s what Mate Maconan of Nokia in Finland put together for—he did that for the 2G phones. And he noticed well if you can send these control messages, why not just send short messages from people.

Weber: So, anyway just an aside about SMS being in the same control channel.

Abramson: And it turned out that there was demand after all for short messages, as we all know and all our grandchildren know, too.

Weber: And was that something that you had thought about?

Abramson: I’d always said that there was a lot of demand for short messages. I had no idea about how it would all work out in terms of implementation or so forth. But I had done a lot of work during that period after Aloha was working for the United Nations in developing countries. And I was pushing for short messages and said look, your communications is so bad. Even a few words here and there is going to be a big help to your economies. But I couldn’t sell things like that, and other people could.

Weber: And the end—so, what other—are there any big contributions Larry made to—?

Abramson: Well, from my point of view I’ve always thought—and I don’t want to argue this on paper because there are so many contenders. But I’ve always looked on Larry as the father of the Internet. From my point of view, where I worked and where I was sitting, he was the guy who got the Internet working. He was the guy who took on AT&T and made them do what they did. And I thought that was terribly important. And then he also contributed technically. So, I always viewed him. But I don’t know. Al Gore I’m sure did something, too. There are lots of other people who invented the Internet.

Weber: But Frank Hart was someone you also—

Abramson: Frank Hart was key. I don’t know if you could say he invented it. He certainly implemented it. Frank was the guy who implemented the vision that Larry had as—from where I was sitting. And he implemented it very well.

Weber: And you had known Len Kleinrock from when you were at UCLA?

Abramson: Not at UCLA. I guess after I was teaching at Stanford, he started teaching at UCLA. And I was aware of work in queuing, which is what Len did. And I just in general thought it was neat work. In fact, I had once tried to recruit Len to come to Hawaii. He was stuck at UCLA.

Weber: Once Aloha was going?

Abramson: Yes.

Weber: And you talked about a house party to celebrate I guess the beginning of—the first phase of Aloha.

Abramson: Well, I’m not sure where I ta—I guess we did have one.

Weber: To Jim Calcain [ph?].

Abramson: I’ll talk about it again. I hope it coincides with where you heard about this. We—it was just a party when the network started working. And we had two terminals because having just one terminal doesn’t make a network. Two terminals, which can interfere with each other, made a network. I thought it was a good idea to get us all together and to celebrate. And we just had a party at our house. All the people who participated in the project were over. And we just had a great swinging time.

Weber: How many people were in the project at that time?

Abramson: Oh, I suppose it depends how you count. But maybe twenty people were working on significant parts of the project.

Weber: Now, I imagine you’re—this all being on the beach but I mean did you actually have a—the house was not right on the beach.

Abramson: It was at my house.

Weber: Right.

Abramson: This is not at the beach. It was at my house.

Weber: So, where did you live in Honolulu?

Abramson: Well, at that time, I lived up close to the University. Subsequently, I moved down so I was close to the beach. My interests were always with the beach.

Weber: And when you were surfing regularly, and a lot of the people on the team were surfing?

Abramson: Yeah, I was surfing pretty much every day. And Wes was a surfer. Tom Garter was a surfer. A lot of the graduate students were.

Weber: But it wasn’t a group activity then?

Abramson: No, we tended to surf by ourselves with—surfers don’t want to congregate in large groups because then you’re competing for the same waves.

Weber: And where were the two terminals?

Abramson: The first two terminals? One of them was at my house. And the other probably was in our laboratory, in the Aloha lab at the University.

Weber: So, you were telecommuting sometimes from your—?

Abramson: I would hardly call it that. There wasn’t—first of all, there wasn’t very much to do on a computer in those days. There was no Internet. And there were certain things I could do through the computer. I could connect. I could send email to various people. And I could run some simple basic programs.

Weber: And this was a custom time-sharing system?

Abramson: This was a custom time-sharing system designed basically by Wes Peterson, Charlie Bass, and John Davidson.

Weber: Yeah, I actually talked about Charlie Bass and John Davidson as students.

Abramson: They were transplanted Stanford students. What I mean by that is they were the kind o f really intelligent, interested, enthusiastic students that you find all the time at Stanford. You have to look for the in Hawaii, but they exist.

Weber: And the particular parts that they did, so they both worked on the—?

Abramson: Was the UH time-sharing system. They worked for Wes Peterson on that.

Weber: So, they didn’t work directly on the Aloha portion of it?

Abramson: Well, it was essential for the Alohanet, otherwise there would be nothing, or very little to do on the Alohanet. Don’t forget email came in after the Alohanet was operating.

Weber: You mean Internet email, or ARPAnet email?

Abramson: Any email. We had email on the Alohanet first. Well, let’s see. The way—let me put it more carefully here. We sent messages on the Internet—on the Alohanet first. Email, in its present—pretty much its present form was introduced to us one day when the network was about six months or a year old when Larry's administrative assistant called and said, "From now on, if you have to communicate with Larry he won't take any more phone calls; you've got to communicate by e-mail." And I said the only thing I could say, which is "What's e-mail?" and—

Weber: You didn't call it e-mail at the time.

Abramson: Well, we did as soon as it was presented to me but I had never heard of it or seen it before and it's much more than just sending short messages back and forth, which we had in the ALOHAnet, it's all of the stuff that—and actually it's—what—the initial implementation of e-mail was remarkably close to what I did this morning on my computer at home; it's hard to tell the two apart. And there was a group of us, about 50, so I was in the—perhaps the first 50 people in the world to have an e-mail address.

Weber: All of the daily stuff with ARPA became e-mail—

Abramson: Became e-mail, yeah.

Weber: —and mailing lists and—

Abramson: Yeah.

Weber: Some timesharing systems had messaging before that of different kinds.

Abramson: I guess so. I don't recall using a message system in any timesharing system. I recall using it in the ALOHAnet because whenever you put together a network the network implies that you have different geographical locations for different nodes and you have to communicate between those nodes and what better way to do it than the network itself so we sent little messages.

Weber: That was a custom implementation they did on the 360 basically to—

Abramson: Well, no, not the 360.

Weber: —protocol.

Abramson: No. It was part of the ALOHA protocols, yeah.

Weber: You were really going essentially computer-to-computer messages and—

Abramson: Yes, there was—and terminal to terminal—

Weber: Could you do this from a dumb terminal to a dumb terminal?

Abramson: Yes, because the formatting was done in the terminal control unit.

Weber: It's like a telex-type—

Abramson: Yeah.

Weber: —system at that point. Apparently, what you told Jim many years ago is you announced the success of phase one of ALOHA at that party.

Abramson: Yeah.

Weber: And someone asked you what phase two was and no one had any idea so—

Abramson: I don't think it was as bad as that. We got it working and once ALOHAnet was working from a technology point of view there were all sorts of things which could be done. The things that were open to us at that time were first of all cable versions of ALOHAnet because Bob Metcalfe had started Ethernet and the first Ethernet was called the Alto ALOHAnet I think, and at the same time the cable people—the television cable people had started their own protocols and had incorporated ALOHA into their protocols; I forget the names of those protocols at this point but they—they're used to this day. And the satellite people could all use ALOHA and they needed ALOHA for terminal connections. Now in all three of those cases there were serious patent issues because we had done no patenting and ALOHA was published in scientific papers and I believe—although I understand from some lawyers that there are exceptions—but I believe that put it into the public domain and that was fine with me. I was too busy surfing to worry about that sort of thing, but nevertheless Bob Metcalfe understood the patent and, more at issue in his case, the standards issues which came up in using ALOHA and he did a pretty good job of incorporating ALOHA in the I triple E standards and in the DIX working group and so forth, and Bob never tried to hide the fact that he was using ALOHA. Now some of the other groups wanted to use ALOHA and they weren't sure about the patent issues, for example COMSAT. COMSAT published a paper I believe in 1976 by a guy named Lipke and others that essentially used an ALOHA channel for a system that they put together called Marisat or the international—it's now transformed into Inmarsat. And I had heard about this through common friends and it was my habit in those days just to drop in—when I was traveling to drop in and see who was working on closely allied areas. So I got a contact with the people at COMSAT and I was going to Washington anyway, which is where they're located, and I said, "Can I drop in and see how you're using some of this technology?" And there was a little bit of a delay and eventually they said "yes" and so I came in to COMSAT at that point and I usually go talk to the engineers and that's about it. In this case, a little—something strange happened. The guy who came out to see me was a guy named Irving Goldstein. Irv was a real nice guy who happened to be the general counsel for COMSAT at the time and who since became CEO of COMSAT and then subsequently was elected CEO of INTELSAT. So he did very—he was a very talented guy, and we had subsequent interactions because I started a conference in Honolulu called the PTC conference which I asked Irv to help sponsor through COMSAT and he did, he was very helpful in that, and he attended some of that, but anyway he came out to see me when I wanted to visit the engineers and said, "I'll take you around." And I didn't think much of it at that point and he took me to these various engineering places and the engineers I realize now were looking a little uncomfortable, and I was clueless though until years later when I start getting involved in companies of my own and realize that there were some patent issues here and that the reason that the general counsel of the company, which was a considerable company, was taking me around and said he was concerned that I had come over to start suing them. I had no idea of that and didn't want to get involved with lawyers to do that kind of thing under any circumstances so we dealt with it and—but COMSAT was always very cagey about calling their ALOHA channels ALOHA channels; they just described them and didn't attribute them to anybody. The same thing was true in some other areas; that is there was a satellite area and these three areas, cables, satellites and wireless networks in general were all using ALOHA but the only one that really fessed up was Bob Metcalfe.

Weber: That's one of the key stories I wanted to ask you about. Is this a good time to talk about—

Abramson: Sure.

Weber: Bob and— Talk about your first meeting. He came over after getting the job at Xerox.

Abramson: After getting the job at Xerox, right, and after his thesis at Harvard was turned down.

Weber: What was he like?

Abramson: Oh, he was Bob. Bob was that—the same way that he is today. He was exuberant, smart, always fun to be with, and he knew what he wanted and he wanted to see how ALOHA worked and learn what he could, and he worked with us at ALOHA for—the period be—has changed a little bit over time. I think one of the items I've read says he spent a month with us. I recollect something like several months but I could be wrong.

Weber: Twenty years ago you said you thought it was up to six months but you weren't quite sure of that—

Abramson: Right, and I've seen anything between six months and one month, but he came over and worked with us, that's the important thing, and he was very forthcoming—well, I shouldn't say "very"—he was suitably ambiguous about exactly what he was going to use but it was clear what he was looking at and—from the questions that he asked and the kinds of things that we'd talk about technically he was interested in an Ethernet cable system.

Weber: You knew that he was designing a wired system to connect some sort of computer.

Abramson: Yes, I knew that and I knew he came from Xerox PARC and I knew what they were doing so—

Weber: Oh, you did.

Abramson: Oh, yeah. It was not too hard to put it all together because Bob Taylor, the guy who was at ARPA when I first contacted ARPA, had subsequently become the research director I guess at Xerox PARC.

Weber: —Alto, that division.

Abramson: That's right.

Weber: He was fairly open with—

Abramson: Oh, I did not talk to Bob about that. I don't—I would—he wasn't fairly open with me but that's because I just didn't have any chance to talk to him. I don't know if he would have been fairly open if I'd talked to him.

Weber: Bob Metcalfe was telling you that they were working on a new kind of computer—

Abramson: No. He was careful not to say too much but at the same time he was technical and he was talking about technical questions and it wasn't too hard to put two and two together.

Weber: What did he actually do in your group?

Abramson: Well, he didn't work on our group. He came over to learn and I thought that was fine. He came over—somebody else was paying his salary. I thought great, more interaction with some good technical people, that's what a university's supposed to do, and so Bob came over, he spent some time with us, we had a few dinners, and he went back.

Weber: Did you give him a desk or somewhere—

Abramson: Yeah. Yeah, we gave him a desk. We had a pretty good little research area that was given to us by the university and I made sure that Bob had what he needed there.

Weber: You were all sitting in kind of the same area with him.

Abramson: Well, I was not in that area, I was at my faculty office, and I never set up an office for me there because I would basically come in and walk around and talk to people but I never worked there.

Weber: Where was that area with him?

Abramson: It was in the university perhaps a few hundred yards away from the engineering building.

Weber: In a particular department or another building—

Abramson: It was in a—what was called a temporary building. There were some temporary wooden buildings that were assigned to us.

Weber: If you walked in there in let's say 1971, what would you see?

Abramson: You'd see a lot of busy graduate students. You'd see some laboratories although the main laboratory was not there; it was in the engineering building. You'd see a lot of terminals and you'd see a lot of software guys.

Weber: The real hardware stuff was more going on in the engineering building.

Abramson: Yeah, the hardware stuff was going on there. We did have a big laboratory there devoted to ALOHA.

Weber: And producing the equipment.

Abramson: Producing the equipment.

Weber: Did you visit all the sites around the islands or some of them or—

Abramson: Not all of them but most of them, yeah.

Weber: Did people really use it actively?

Abramson: There was—there were several that were used here and there I wouldn't say actively in the sense that we look at it today. After all, there weren't all the resources available that the Internet provides us but there were people who were using it for basic programming, there were people who were using it for messaging, and then there were some sites which we had which collected the wind velocity and direction and those were sensor sites.

Weber: But there was some person to care for those or make—

Abramson: Yeah, in each case there was somebody to watch over it, but the person who mostly was involved with that were—or there were two people. One was Alan Okinaka who of—I mention—I've mentioned earlier and Dave Wax and those two guys did a lot of that work.

Weber: For some people this was their only way to connect to a computer on some of the locations.

Abramson: Yes. Yeah, but connecting to a computer was not all that important in those days.

Weber: What was Dick Binder's role?

Abramson: Richard was the guy who taught me what a protocol was. He was in charge of the protocols. He was a graduate student getting his master's but very—one of these very talented people who knows how to make things work, and what I liked particularly about Richard is that he was not afraid to tell me that I was wrong and I was wrong with good frequency and he would—he was one of the people—there were some others but Richard was pretty frank and I liked that.

Weber: He was working on protocols but you were not participating that much in the standards process though or—

Abramson: I was, remember, a communication theory guy.

Weber: Right.

Abramson: —and—

Weber: I don't mean you personally—

Abramson: Oh.

Weber: To what extent was he interacting with other people in ARPA say around protocol?

Abramson: He was interacting quite a bit. He came in as a fresh graduate student. We talked a little bit, I assigned him to do some of this work, and he basically took it over and ran with it and he became a key guy for the protocols in the network.

Weber: He was going off to meetings or doing more of it by e-mail or—

Abramson: Right.

Weber: —both.

Abramson: You might want to talk to Richard by the way. He's in the Bay Area.

Weber: I know.

Abramson: Oh, okay. I saw him a couple times since he's been here and we talked about the old times, but he—he's a probably a good source for a lot of stuff that I don't know.

Weber: Yeah, definitely. You were traveling to the mainland regularly for meetings and—

Abramson: Yeah, I was going there meeting with ARPA in Washington quite a bit.

Weber: A few times a year?

Abramson: Yeah, two or three times, maybe more, and I still had contacts at Stanford and at UCLA.

Weber: The blackboard story.

Abramson: Oh, okay. I've written this so I hope it's what I've written. The—this occurred—I'm just guessing now—probably somewhere in oh, '71 or '72. I was visiting Larry Roberts at DARPA offices in Washington and one of the things that I wanted to talk about Larry—we talked about a lot of technical things but one of the things I had—this was when people were connecting their units—their computers to the ARPANET and there were lots of universities getting connected and I thought oh, gee, we should get connected too now so I—I'll talk to Larry about connecting the ALOHAnet to ARPANET, which probably was—when it finally occurred was sort of like the first Internet; it was the first network of network stuff that I know of but—

Weber: Seventy-two or so. Right?

Abramson: Something like that, yeah, and so we were talking and I noticed on the blackboard in Larry's office there was a list of universities—various universities and dates for which to install the IMPS or the interface message processors to connect the universities to the ARPANET, and I said, "Fine" I—to myself, "we'll try to get on that list," but before the meeting was over Larry was called out to an emergency. And if you know how DD—DOD meetings are it's very rank oriented. Somehow his boss had something which had to be done right away and so Larry was called out of the meeting to take care of this little fire; it was just about five minutes. And I was there sitting in Larry's office looking at this list of universities and dates by which they were to be connected to the Internet—to the ARPANET, and so while Larry was gone I just got up from my chair and I took the chalk and I wrote "the ALOHA System" as—on the list of university projects and I picked a date at random, December 12 or something that year. And I put it on the board and I thought okay, I'll talk to Larry about this when he gets back. Well, Larry came back and we sat and talked for a while, but somehow we had a list of all sorts of interesting technical stuff that we never got to discussing the list, and I left the meeting and I forgot about it but I left the listing of the ALOHA network on his blackboard with the date. Sure enough about a week or so before that date, December 5, I got a call from one of Frank Hart's people saying, "Would you please prepare a place? We're going to install a satellite IMP at your university so you can connect to the ARPANET" and I got the call directly and I handled it and I said, "Oh, you're going to do that. Okay, we'll have it ready for you." And sure enough on December 12 or whatever the date was they rolled in with a—the first satellite IMP, connected us to the ARPANET on the mainland via satellite, and we were off and running with another connection to the ARPA satellite network and—to the ARPA network and it became a network with satellites in it when we were connected. So that's how we connected to the ARPANET.

Weber: Then the e-mail started up sometime shortly after that I would—

Abramson: I—let's see. I guess—yeah, the e-mail had to have occurred after that.

Weber: That's in the right time frame. And then—

Abramson: It's a lot more efficient way of doing things by the way than writing proposals and getting approval.

Weber: It was only a year or so more before you stopped being funded by ARPA. Right?

Abramson: Yeah. We I guess ran out of ARPA funding around—it must have been around '76 or so. We then picked up a lot of funding from NSF, from various companies; particularly IBM and NEC both provided a lot of funding for the project.

Weber: Could you talk a little bit about any other big steps while still under ARPA? Then I know that when Bob Kahn came in and packet radio started there was sort of a parting of ways.

Abramson: Well, it wasn't Bob so much. There was—this was during the Vietnam War and DOD was a little sensitive to how their technology—how public their technology was, but of course they really couldn't do any other kind of technology at most universities; some of it had to be public. The ALOHA project was pretty open in some ways, which probably made the Department of Defense uncomfortable. We had two visitors from the Soviet Union for example, Boris Tysbakov and Kamil Zigangirov, while ALOHA was getting up and running, and then I spent about six months on a UN project—I spent six months— Go ahead.

Weber: Let's back up a little bit. You had Boris—

Abramson: Boris Tysbakov and Kamil Zigangirov, two Soviet scientists who came over, and they were paid for by the Soviet Union but they were working with our people and as a university we just felt we don't want to keep secrets, and it wasn't classified so we were perfectly happy with these two Soviet scientists. Now the fact that they were able to get out of the Soviet Union in those days told us a little bit about their reliability from the point of view of the Soviet authorities, but we didn't—it didn't particularly bother us. In addition, I took a sabbatical and I spent six months of the sabbatical working for DOD at a communications research facility in the Washington area but I also spent six months of my time working in Budapest when Budapest was behind the Iron Curtain. So Joan and I went out to Budapest and lived there for six months while it was still a communist-run—

Weber: What did you do there?

Abramson: I helped set up a communications institute, a technology institute, for them in Budapest and it was sort of fun and it was very eye opening for me, for Joan and for my two children living in a communist society at that point, which worked out okay.

Weber: This had repercussions.

Abramson: I think it made ARPA uncomfortable, and the final straw I think is that I didn't want to continue as director of the project so I asked another faculty member who had joined us at that point, Mike Ferguson, to serve as director at least for a while, and Mike was unfortunately foreign, he was Canadian, and this—I had a meeting with—there was a colonel in the office of ARPA at the time—this was all Vietnam and universities and DOD were having their problems—and he looked at me and said—I told them Mike was Canadian and he was going to run the project and he said, "Well, Norm, that makes me uncomfortable." And <laughs> I perhaps should have taken that more seriously, I didn't, and sometimes then we had to have meetings at ARPA with some of the nonmilitary people in cars because I guess people were worried about what would be overheard or—I didn't like that either so we had a parting of the ways and it worked out okay. I'm sure it didn't affect ARPA that much and it didn't affect us that much and we were both more comfortable that way.

Weber: That's right around the time that the packet radio project started at ARPA.

Abramson: Yeah, around the time that packet radio was—you mean the one at SRI.

Weber: Right.

Abramson: Yeah.

Weber: Did you have much contact with—

Abramson: I did not have much contact with that, no.

Weber: It was the Vietnam era and certainly within ARPA's funding there were all sorts of extremes from hippie hackers to generals and protests. How did that play out and—

Abramson: Well, during that time universities everywhere had their protests and the University of Hawaii was no different, but we were running a DOD-funded unclassified project and there were some student groups who didn't like that, and the person who seemed to be in charge of that—or the student who seemed to be in charge of the protests, and there were protests close to where we were, was pretty—he was some—he was a student who was not too level-headed but he didn't like the fact that we were doing DOD work. And so I just invited him over and I talked to him about it and told him it was unclassified and it was supporting all these students and this good research and he was sure that there was some nefarious thing going on so my way of dealing with it turned out to be pretty successful. I said, "Look. If you think we're doing something that is worth protesting, I'm going to give you complete access to all of our files. You have—just don't do any damage;"—and he agreed not to do any damage—"anything you want to see you can see." I showed him where all the files were and let him spend a few days there. Well, he very quickly got bored and that was the last I heard of the problems and we were never affected by the University of Hawaii protests—the Vietnam protests in those days.

Weber: Did any of the people on the project have mixed feelings?

Abramson: Yeah. One of the—there was a particularly—she was an administrative assistant and she was very—she was overqualified for her position, she was really very good at what she did, and she came over to me and said, "Norm, do you really want to do this?" and she argued a little bit against it, not vehemently, and I—we had a discussion and I said, "Give it a try. It's not going to do any harm and you know that we don't have anything that we're really hiding" and she knew that. And so she was a bit uncomfortable the first day but eventually she thought it was a pretty good way to handle it too.

Weber: After you stopped getting ARPA funding—

Abramson: We had funding probably not at the ARPA level but we had some pretty good funding from IBM because IBM in fact had started building with Motorola a packet radio unit and were using these packet radio units for connections for its technicians connecting from customer locations. They didn't want to use the customer's telephone, there weren't any mobile phones, and so they used those so IBM knew it was ALOHA. I should say they didn't call it ALOHA anyway but nevertheless they knew it was ALOHA and they were very helpful providing student support, and I set up a little industry group, IBM subscribed to it year after year, and they provided extra funds beyond that. NEC did the same thing and they would keep sending us people and money and universities are fund-absorbing organizations and so that worked out well.

Weber: What did they do with the research?

Abramson: They did a lot of satellite connection using ALOHA and they developed that. They still use a lot of ALOHA in their satellite stuff these days. They did not get into wireless in a big way but they were very helpful in bringing people over to work with us and in providing funding for us, and then Fujitsu and Boeing and lots of other companies like—oh, and 3Com—Bob set up—Bob Metcalfe set up something with 3Com so we had a lot of other companies that were helping provide the support after the ARPA support was gone.

Weber: When did the network itself stop?

Abramson: Well, the network itself was—it was being run on experimental frequencies. Remember the issue was what frequencies do you use. Well, we got some military frequencies which were used only for experiments and only for a given amount of time so that was coming to an end around the same time and we just let it lapse.

Weber: What era would that be?

Abramson: Whatever the—whenever the ARPA support went out and probably about '75, '76 the ARPA frequencies were withdrawn as well because we had done the experiment on those frequencies that we said, there were no other frequencies on which to use ALOHA, and so we had to wait for WiFi and we had to wait for 1G phones but they came.

Weber: In the late '70s, you were still being supported for research and into the '80s.

Abramson: Yes.

Weber: When did it really wind up?

Abramson: Probably—well, it didn't wind up formally until I left the University of Hawaii when I retired and I retired around '95.

Weber: Tell me the main phases of the later research.

Abramson: The later research was in a whole variety of things. Some of them dealt with developing countries because after ARPA went away another thing that happened to me is I started doing some work for the United Nations for UNESCO and UNDP and other UN agencies and became interested in applications of ALOHA for developing countries who didn't—that didn't have infrastructure. And I did a good amount of that in—I guess I started with Budapest but I did a good amount in Manila, throughout the Pacific in developing countries and—oh, let's see—there were several other places where I spent a good amount of time.

Weber: With telephone companies, mobile telephony, you didn't have any direct—

Abramson: No, I didn't, and in fact the—a lot of the work which incorporated ALOHA, first of all in 1G and—in the signaling and then in 2G in the SMS and then in the 3G for larger files. All of that was done—I was aware of it but I was not involved in it.

Weber: What became WiFi?

Abramson: WiFi—I was only involved a small extent with not WiFi as such but with the allocation of the frequencies, the unlicensed bands. There was a guy who was one of the really—he shouldn't be unknown but he seems to be more unknown than—I would give him a lot more weight; people should know more about him—who was in the FCC—

Weber: What's his name?

Abramson: Mike Marcus who basically is another one of these people who can get big organizations to move in a sensible way. I never had that ability and maybe the reason I didn't is I know how much effort it cost him and how much effort it cost Larry Roberts. It's not easy to get a big organization to move in a different, sensible way. Mike Marcus got the FCC to allocate the unlicensed frequency bands. It was—

from my point of view, it was almost singlehanded and over a long period of time and he was successful and that—of course that led to WiFi.

Weber: Anything else in your later career you want to touch on?

Abramson: I—we've covered a lot of stuff here, Marc, so <laughs> I can't think of anything else that's—that I would call historical. Maybe not enough time has passed for it to become history.

Weber: Looking back, what's the accomplishment you're most proud of?

Abramson: Certainly, the establishment of wireless data networks. The first wireless data network was ALOHA. I'm particularly proud of the—what I did there because I had some doubts about whether I could do the hardware. I knew the theory and I knew that theoretically it was all going to work but that was the first time I ever got my hands on a real hardware project, and it was a lot of fun and I—I'm proud that it was so—done so successfully by the people who knew how to do it but at least I chose some good people.

Weber: Anything else you'd like to add—

Abramson: I would just close with "aloha."

END OF INTERVIEW

